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ABSTRACT

A survey of the literature concerning the mental processes used in reading reveals a proliferation of molecular theories which explain only a small (and frequently neurological) component of the reading act. Enough information exists, however, to sketch an integrated, molar model of the reading process, which stresses the interrelationships between conscious and subconscious channels of thought. Efficient reading is an interaction between long-term and short-term memory and the affective domain. Cognitive competencies (analyzing, synthesizing, inferring, evaluating, etc.), although not innate, originate in a subconscious channel: the goal of the reading teacher should be to teach both graphemic and cognitive skills, to the extent that they become unpremeditated responses. A molecular model derived from this molar model suggests that the sequence of language factors (phonology, morphology, syntax, grammar, and semantics) is reversed in the reading process. (KS)

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A TIME FOR HERESY: A MOLAR READING MODEL

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MOLECULAR READING MODELS

The mental process of reading is so fractured by theories and models that all the reading specialists may not be able to put it back together again. A molar model is almost heresy among theoreticians and researchers who believe the whole to be too complex for scientific study. They prefer molecular paradigms with fewer variables to control. Kety (1968, p. 308) pinpoints the major disadvantage of molecular emphasis when he writes, "...we do not always get closer to the truth as we slice and homogenize and isolate, that we gain in precision and in rigorous control of variables we sometimes lose in relevance to normal function, ..., the fundamental

process may often be lost in the cutting." Bateson (1963, pp. 182-183) explains, "...the subject trained in an instrumental philosophy will, ..., encounter a universe which will seem to him to validate that philosophy..." Theories and models may give their authors mental sets insensitivity to reality. Their research designs may generate statistical artifacts which reinforce this insensitivity. That is, the research designs manipulate the subjects' performances in a manner to verify the models, but do not necessarily express the variability and limitations of subjects to perform.

When a molecular model becomes a researcher's universe, he feels no need to integrate his knowledge into a molar kaleidoscope. The molecular model having the greatest influence on reading theory is the telephone switchboard. Lindsay (1963, p. 35) writes, "...students of behavior still exhibit a propensity to describe the human system in terms of the engineer's handiwork. In the first half of this century, and still today, psychological models took a form remarkably similar to the telephone switchboard, with incoming signals being routed through connections, strengthened, by degrees, through use, to trigger a response..." Holmes' (1976) Power of Reading model is a good example of a molecular theory set in the molar isolation of a universe. Holmes used the statistical technique of substrata-factor analysis to splinter the molecular component of language in reading. Among the splinters he strung enough "switchboard" connectors to weave an appearance of science only a heretic would question.

Holmes (1976, p. 611) states, "Each subsystem is a composite of yet smaller and smaller systems; in fact, it is hypothesized that the very microsystems constitute tiny engram-assemblies of the cortical cells themselves."

To endow this hypothesis with authenticity, Holmes (1976, p. 615) writes, "The neurological evidence for the hierarchical conception of mental structure is common knowledge in neurology, ..." What is common in neurology relative to the engram is that none of the theories pertaining to the engram or memory trace has withstood all the shafts of objection (Brown, 1976, p. 235). After Lashley (1950) had cut his way through numerous rat and monkey brains in search for the engram, he said, "I never managed to catch up." Hebb (1949), like Lashley, thought the engram involved physical changes at the neuronal level, notably, the formation of new neuronal material. Knappers, Huber, and Crosby (1936) suggested stimulation of embryonic nerve fibers caused them to grow towards the source of activity. Despite some evidence that postnatal environmental stimulation increases brain weight (Bennett et al., 1964; Rosenzweig, 1970; Rosenzweig, Love, and Bennett, 1968), no direct correlation between any kind of neural growth and learning has been established.

Other explanations of the engram process have involved changes in synaptic membrane permeability (Eccles and McIntyre, 1951), alteration of neuronal threshold levels (Morrell, 1963), changes in the glial cells (Galambos, 1961), qualitatively selective chemical sensitization of neurons (Deutsch, 1971; Milner, 1961), and selective sensitization to specific activation patterns (Burns, 1958).

Singer (1976) delineated a progressive acquisition grade scale students follow in achieving the skills Holmes identified as being essential to power in reading. Actually, Singer's contribution is more meaningful than his mentor's (Holmes). Perhaps, Singer has opened the door to a

schedule of automaticity for acquiring the skills to read with power. La Berge and Samuels (1976) approach the reading process with the power of automaticity but failed to exploit it with the reader's ability to attend selectively. Driver (1968, p. 276) explains, "Throughout the animal kingdom, organisms attend selectively to various stimuli responding to some positively, to others negatively, and to many more not at all." Goodman (1976) emphasizes the reader's ability to attend selectively in a milieu of phonological, grammatical, and semantic cues. Gough's (1976) model shackles the reader to the smallest detail in print, thereby negating all tendency to attend selectively. Thus, Gough's model, and those similar to his, is least realistic about the reading process.

Crosby and Liston (1968), Geyer (1970), Mackworth (1971), Roberts and Lunzer (1968), Ruddell (1976), and Sperling (1970), like Goodman, view the reading process basically from the perspective of language. With a sequence of molecular steps neurophysiologists have not been able to verify, they run the reading process through a neuro-language morass. With the exception of Crosby and Liston's model, none project a reading process eventually free from the straits of language. Since these models are entangled in neurological projections, their verification by research must wait until more is known about neurology.

Are We Limited to Molecular Models?

Gibson and Levin (1975, p. 438) asks, "Can there by a single model for reading?" They answer, "If there is no single reading process, but instead many reading processes, there can be no single model for reading." Of course, this position reflects the homily: the fewer the facts available, the more theories there are. Athey (1971, p. 3-6) concludes,

"...We are a long way from achieving a comprehensive model of either reading or language or from an integrated model of the two processes.... Until such a model is forthcoming, we need models which may be partial in the sense that they explain only restricted portions of the total process or in a sense that they represent only a subgroup's mode of functioning rather than the basic process per se."

We do have enough information to sketch a tentative, integrated, molar model of the reading process. What we lack is the knowledge to precisely mark the molecular boundaries for the affective domain, language competencies, cognitive competencies, subconscious facilitation, conscious participation, short- and long-term memories in this puzzle. Too much effort has been expended on carving out a few pieces of an unseen whole. Surely, this carving out already outruns the available data on the reading process. Model-making is an occupational disease of reading specialists (Wells, 1975, p. 461). The infection is striking again with an erupting rash having molar dimensions. It is hoped that the mind will be able to impose on this molar model an important constraint, namely, that it is expressed precisely. The goal is to make explicit assumptions that have too long been so implicit that they have not been susceptible to experimental investigation. To be really useful, however, the model must generate verifiable predictions about reading behavior (Michie et al., 1975). Molecular models omit too many interrelationships (that is, they are so incomplete) to generate verifiable predictions. Thus, their usefulness is almost nil.

A MOLAR MODEL

This molar perspective of reading envisages a kaleidoscopic interrelationship among conscious and subconscious channels. The conscious channels house the short- and long-term memories. The subconscious channels house all the mental operations and "thermostatic" controls an organism needs to function involuntarily or automatically to perform any task in an efficient and parsimonious manner. Neurophysiologists (Appel, 1972; Bachelard, 1974; Glassman and Wilson, 1972; Gurowitz, 1969; Morrell, 1963; Rose, 1975; Roy, 1970; and Squire and Barondes, 1972) are convinced of the reality of short- and long-term memories. Agranoff (1970) continues to propose that short-term memory lasts until long-term memory storage is accomplished and is actually converted to long-term memory. Beritashvili (1971, pp. 124-125) believes there are various forms of memory. He wrote, "A deeper insight ... will naturally yield new evidence on the molecular chemistry and ultrastructure of neural and glial elements, as well as on the physiological peculiarities and interconnections of cortical neurons. These new data will shed clearer light on the origin of the various forms of memory: image, emotional, and conditioned-reflex memory, and thus enable scientific understanding of the origin of the highest form of human memory--verbal-logical memory." Gerard (1963, p. 365) stated, "There is conclusive physiological and phychological evidence, at most, there are different arrays or patterns of neuron groups which subserve different memories, with some spatial separation as well as overlap." Jarvik (1970, p. 22) concluded, "...there is strong evidence that many types of memories successively survive amnesic treatments or are not facilitated. One would have to conclude

that these memories are consolidated rapidly, perhaps instantly, whereas the susceptible memories are consolidated slowly."

Understanding the reading process requires a knowledge of what memories can be activated automatically or involuntarily and what memories require consciousness on mental awareness for activation. The molar model suggests that short- and long-term memories require consciousness for activation. This model, unlike most molecular reading models, ascribes to short-term memory the role of processing and consolidating any new information the organism receives. Neurophysiologists discovered short-term memory by studying the brain behavior in naive subjects learning a new task. They have found no evidence to support short-term memory being activated by an experience or stimulus that is not novel. An experience or stimulus ceases to be novel once consolidation occurs and other memories can deal efficiently and effectively with it. Frustration and/or a decrease in learning occurs when too many novel stimuli are dumped into short-term memory. Schnitker (1972) wrote, "An excessive massing of experience and information leads to poor organization in the brain.... Very few experiences per hour can be consolidated as far as we know from the physiological and behavioral evidence." Reading specialists are familiar with the criteria for the frustrational level in the Informal Reading Inventory. They are: Comprehension less than 75% and more than five word attack problems in a hundred running words. This type of reading performance dumps too much stimuli into short-term memory.

Long-term memory is the store for information an organism cannot efficiently use when stored in psychomotor memory or the subconscious. This information forms the basis for comprehension and may be manipulated

by the cognitive processes of translation, analysis, synthesis, application, inference, evaluation, etc. Bachelard (1974, p. 65) reported, "Studies based on lesions of various brain regions and consequent disturbance of memory have indicated areas of the hippocampus and amygolala of the limbic system to be associated with short-term memory, and the 'association regions' of the cortex ... with long-term memory." Rose (1975, p. 233) agrees: "There is evidence from neurophysiology and neuroanatomy that the anatomical localization within the brain of the short- and long-term stores is different: the short-term store is probably located in the hippocampus, part of the limbic system, located deeper in the brain than is most of the cerebral cortex, while the long-term store is in the cortex itself." Squire (1972, p. 76) surmised, "...short-term and long-term memory systems may either be completely separate or they might depend on each other in a variety of ways." The molar model of reading suggests they both function in conscious channels. The model assumes that no stimulus enters the short-term memory store if it can be matched with an experience already consolidated in long-term memory.

The molar model defines efficient reading as a performance controlled in part by subconscious memories. Miller (1975, p. 213) wrote, "Since our capacity to remember limits our intelligence, we should try to organize material to make the most efficient use of the memory available to us. We cannot think simultaneously about everything we know." Hess (1964, p. 7) explained, "...We have an increasing widening of memory through psychomotor experiences gaining in variability. At the same time, certain phases of movement become automatic. In this way, consciousness also is eased and in certain cases can turn to other interests." The human

mind can only efficiently interpret phonological and graphemic symbols unconsciously. Thus, efficient reading requires that aspects of decoding be accomplished by the power of psycho-motor memory automatically. When a reader cannot unconsciously decode one or more units in a stream of graphemic symbols, the performance spills first into a conscious channel of long-term memory. If no information is consolidated and viable in long-term memory to help solve the problem, then the spill spreads to a short-term memory channel where either of two things may occur: (1) The experience is consolidated and stored where it may be applied to help solve a similar problem in the future should one arise. (2) It fades and no consolidation occurs. Thus, if a similar problem arises in the future, it will again be novel to the mind and will go to short-term memory.

Excessive spills into short-term memory may activate the affective domain to a conscious state. Hess (1964, p. 56) wrote, "...Activation of moods and their coordinated expressions are apparently closely related to parts of the septum, to the hippocampus and to the cingular gyrus." He continued (p. 73), "...An experience that has a feeling tone rarely mobilizes one organ alone but generally a whole group of organs. It depends largely on the intensity of the feeling tone whether a specific influence is limited to one functional system or whether the stimulus will spread out and under certain circumstances will break through the limits of organic order and irradiate into other systems." Since the affective domain regulates an organism's survival and nervous system only from input in a current environment, it can dominate and block action in all other memories when a perception of danger to both or either of its biological and social existences occur. Thus, a calm affective domain is essential to efficient

reading. Even a state of exuberance will block functioning in other memories. The affective domain supports reading best when it is in the unconscious state of equilibrium.

Cognitive competencies (analyzing, synthesizing, inferring, evaluating, etc.) originates in a subconscious channel. That is, a mind adept in these cognitive competencies perform them without conscious direction. However, they are not innate. The Harlows (1975, p. 254) wrote, "Thinking does not develop spontaneously as an expression of innate abilities; it is the end result of a long learning process.... The brain is essential to thought, but the untutored brain is not enough, no matter how good a brain it may be." As the reading teacher must teach the graphemic code so effectively that her pupils learn to subconsciously apply it, she must also do the same for the cognitive skills. This task is not as delineated as the decoding task is. Yet, it is as important. The mind that must stop and consciously think, "I am going to make an inference," will not make many inferences. Beritashvili (1971, p. 90) wrote, "...although complex logical memory in the normal human adult predominates, he conducts himself in his behavior to a significant degree according to image, emotional and conditioned-reflex memory." One goal of reading instruction is to increase a student's unconscious use of the higher cognitive skills.

A conception of the Molar Reading Model follows for a frustrational reading performance in 500 running word.

A MOLAR MODEL OF READING

Reading Memories			100	200	300	400	500
Conscious	Short-term		L + d	dp	L +	P L d	L d L
Memories	Long-term	L	P d	–	d	d	+
Subconscious	Graphemic Symbols	d	P		P	P	P
	Phonological Symbols	P					
	Affective Domain	+ –					
	Reflex	r					
Memories	Cognitive Skills	C	d	d d	P		P
Conscious	Long-term	L	– C		C	d –	–
Memories	Short-term			C L	–	+	C L

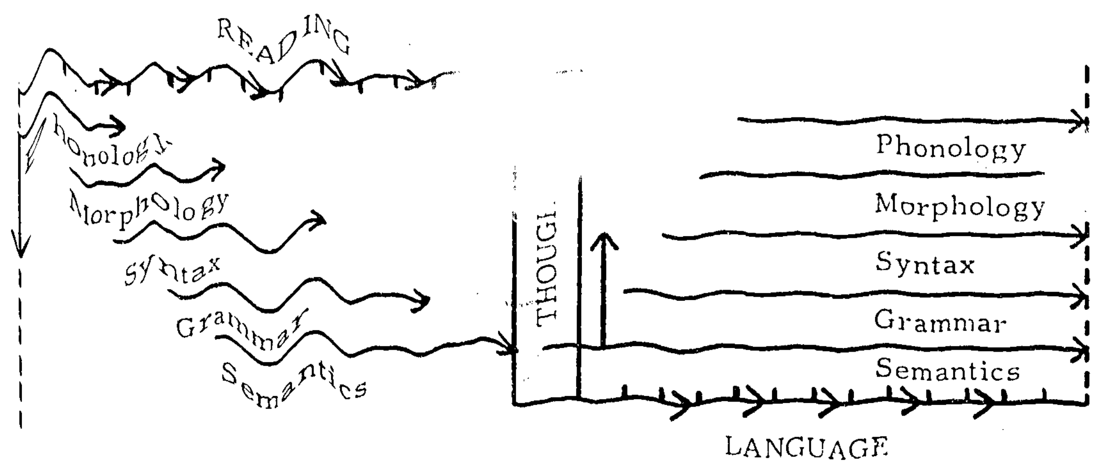
Running Words

Research needs to determine what constitutes a positive interaction among memories for efficient reading. Excessive activation of short-term memory surely interferes with efficient reading and learning; yet, some activation is essential for learning to occur. The information in the above model suggests too much information is entering short-term memory. And, too much diverse information demand can be made upon long-term memory. For example, if long-term memory has to spend excessive time processing the code, it will take energy away from comprehending. Thus, where a code mark for long-term memory (L), for graphemic memory (d), for phonological memory (P), for affective domain: positive (+), negative (-), for reflex memory (r), and cognitive skill memory appear in the channel for another memory, it indicates that it is usurping the mental energy that a particular memory should devote to the reading task.

A MOLECULAR MODEL IN THE MOLAR MODEL

A molar model may generate paradigms to depict molecular constituents and their activities or roles in the whole process. For example, the Molar Model of Reading stimulates the author to ask: Does the mind subconsciously function with graphemic symbols the way it does with phonological symbols? The answer to this question will tell us whether efficient reading is a language act or whether it has enough characteristics to warrant classifying it as a language act. The following molecular model depicts how reading and language may differ as an expression of thought.

THE TWAIN: LANGUAGE AND READING--Do They Meet?



This molecular model suggests the sequence of language factors are reverse for reading and speech. In the reading process, graphemes stimulate phonology, making it the first of the five language characteristics (phonology, morphology, syntax, grammar, semantics) to be activated. However, in efficient reading, it soon fades; but, it never fades in speech even though it may be the last of the characteristics to appear. Thought initiates language; thought is a derivative of reading.

This molecular model suggests the latencies for phonology, morphology, syntax, grammar, and semantics differ for reading and language. Thus, viable research opportunities are generated by the model. Mature readers who have mastered the decoding and cognitive skills, to a degree of subconscious performance, will be the best subjects for this research. Such research will help determine how the acts of reading and language are similar, and how they differ. Once this is known, a definition of reading will be nearer for the profession.

This molecular model raises the questions: (1) Is the mind dependent upon language for stimulation as well as expression? (2) Can a mind

have and process a thought without language? Brown's (1970, p. 274) research with the "Tip of the Tongue" (TOT) phenomenon sheds some light on this. "Everyone knows the state--you cannot recall a word, even though you know it perfectly well, and a kind of intensive search is set up in your brain, a search that tosses up a succession of words which are not the one sought but are quite tantalizingly close." Certainly, the mind first has the "muscle" and then searches for the "skin." Vygotsky (1963, p. 126) wrote:

> Thought and word are not cut from one pattern. In a sense, there are more differences than likeness between them. The structure of speech does not simply mirror the structure of thought; that is why words cannot be put on by thought like a ready-made garment. Thought undergoes many changes as it turns into speech. It does not merely find expression in speech; it finds its reality and form. The semantic and the phonetic developmental processes are essentially one, precisely because of their reverse directions.

Vygotsky (1962, p. 150) said, "Thought, unlike speech, does not consist of separate units." Efficient reading may be close to what Vygotsky (1962, p. 149) defines as inner speech:

> Inner speech is not the interior aspect of external speech--it is a function in itself. It still remains speech, i.e., thought connected with words. But while in external speech thought is embodied in words, in inner speech words die as they bring forth thought. Inner speech is to a large extent thinking in pure meanings. It is a dynamic, shifting, unstable thing, fluttering between word and thought, the two more or less stable, more or less firmly delineated components of verbal thought.

Efficient reading might be a process in which nominals are emphasized the way Vygotsky (1962, p. 145) believed predication was in inner speech. He wrote, "Predication is the natural form of inner speech; psychologically, it consists of predicates only. It is as much a law of inner speech

to omit subjects as it is a law of written speech to contain both subjects and predicates." If inner speech is a search for predicates to express the actions of subconscious objects, reading could be a search for nominals in print for which a mind can subconsciously supply the predicates. Before the reading process is thoroughly understood, more research must be done with m[illegible] readers as subjects. Our college campuses are the best place[illegible] in[illegible] subjects. Subjects in whom we can study the roles of consciou[illegible] and subconscious channels in reading; the roles of short-, long-term and other memories in reading. Let us crawl out of the darkness of the neuron so we can have the whole view of reading while we conduct our research.

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